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FLIGHT AND AEROSPACE RESEARCH
Airborne Simulation and Research Investigations, 1999 - 2004

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THIS TECHNICAL REPORT HAS BEEN REVIEWED AND IS APPROVED FOR PUBLICATION.

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14. ABSTRACT

This report summarizes General Dynamics Advanced Information Systems (GDAIS), (formerly Veridian) activities under the U.S. Air Force In-Flight Simulation and Research Investigations Contract No. F33615-99-C-3000, which became effective in February 1999. The contract was sponsored by the Air Vehicles Directorate of Air Force Research Laboratory (AFRL). The objective of this contract was to conduct in-flight simulation investigations and tests using the U.S. Air Force in-flight simulator aircraft--the NF-16D Variable Stability In-Flight Simulator and Test Aircraft (VISTA), SIN 86-0048 and the NC-13H Total In-Fight Simulator (TIPS), SIN 53- 7793. An additional study task, not directly using these aircraft, was also performed. Each investigation was independent, had a specific objective, and was reported separately.

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1. Introduction

This report summarizes General Dynamics Advanced Information Systems (GDAIS), (formerly Veridian) activities under the U.S. Air Force In-flight Simulation and Research Investigations Contract No. F33615-99-C-3000, which became effective in February 1999. The contract was sponsored by the Air Vehicles Directorate of Air Force Research Laboratory (AFRL). The objective of this contract was to conduct In-Flight simulation investigations and tests using the U.S. Air Force In-Flight simulator aircraft -- the NF-16D Variable Stability In-Flight Simulator and Test Aircraft (VISTA), S/N 86-0048 and the NC-131H Total In-Flight Simulator (TIFS), S/N 53-7793. An additional study task, not directly using these aircraft, was also performed. As required by the task order contract, each investigation was independent, had a specific objective, and was reported separately. This contract was performed by the Flight and Aerospace Research department of GDAIS in Buffalo, NY. The Flight and Aerospace Research senior manager was Mr. Louis H. Knotts. Mr. Norman C. Weingarten was the overall Program Manager as well as the Manager of TIFS and Study tasks. Mr. John F. Ball was the VISTA Manager until he retired in October 1999. Mr. Thomas Joseph was VISTA Manager from October 1999 through April 2000, when Mr. Weingarten took over those responsibilities.

Technical management of this contract for the U.S. Air Force was carried out by the In-flight Simulation Program Office of AFRL. The AFRL In-flight Simulation Program Manager was Mr. Steve Markman until November 2000 when Mr. Luis Piñeiro took over these responsibilities.

This final report provides an overview of the tasks performed on the In-Flight simulation contract over the past five years. Section 1 provides a summary of the task and In-Flight simulator aircraft flight and systems improvement activity. Section 2 provides a description of the contract management and support activities. A summary of the maintenance activities is discussed in Section 3. The main portion of this report, however, is contained in Section 4. This section contains a brief description of the 32 tasks performed on this contract. A list of technical memoranda such as Task Plans or Test Plans which were prepared over the course of the five-year contract is presented in Section 5.

1.1 Summary of All Activity

The 1999 to 2004 contract period was a momentous time in the history of In-Flight simulation. During this period, VISTA was used heavily, while the TIFS had only one major project early in the contract; also, the AFRL role of operating test aircraft ended and the aircraft operated under this contract found new homes. By the end of this contract, VISTA was transferred to the Air Force Test Pilot School (AFTPS) at Edwards AFB and TIFS was transferred to a Cooperative Research and Development Agreement (CRADA) between AFRL and GDAIS, where it has resumed flight operations. Both are still alive and well, continuing to support US military and commercial flight programs.

This contract began in March 1999 and continued through February 2004. It was a continuation of previous In-Flight simulation operations contracts with AFRL. GDAIS has been involved with both of these aircraft since inception, having developed both the VISTA and TIFS and operating them continuously for AFRL since 1968 (TIFS) and 1995 (VISTA). A description of the activity on these two aircraft is detailed in the following sections.

1.1.1 Summary by Task. The investigations under this contract provided support to the Air Force, Navy, NASA, other government and foreign agencies, and industry in the areas of control law design/analysis, flight control and flying qualities research, novel control law algorithms, control system hardware, displays, pilot training, human-machine interfaces, and the interactions between these factors and other airplane subsystems. A summary of the investigations performed on this contract and respective funding, by aircraft, is shown in Table 1. A summary of the investigations performed on this contract and respective funding, by category, is shown in Table 2.

Table 1

SUMMARY OF TASKS AND FUNDING BY AIRCRAFT

Aircraft	No. of Tasks	Funding
NF-16D VISTA	24	$7,401,997
NC-131H TIFS	7	$1,688,943
Non-Aircraft Related	1	$93,316
TOTAL	**32**	**$9,184,256**

Table 2

SUMMARY OF TASKS CATEGORIES AND FUNDING

Category	No. of Tasks	Funding
In-Flight Simulations	8	$2,011,266
Test Pilot & Other Training	9	$2,606,479
Improvements	3	$1,437,776
Support	5	$2,326,683
Maintenance	6	$708,736
Non-Aircraft Studies	1	$93,316
TOTAL	**32**	**$9,184,256**

In-Flight simulation projects accounted for eight of the tasks on this contract. The VISTA was used at the AFTPS for three Test Management Projects (TMPs). These student run projects dealt with: HUD symbology, PIO prediction criteria, and a PIO detection and compensation filter. Preparations started for a large simulation program in support of the Boeing JSF, but it was canceled early in the effort when Boeing decided to redirect their simulation efforts. There were four TIFS tasks directed towards simulation programs for NASA's High Speed Civil Transport and Synthetic/External Visibility projects. Details of these and the other tasks summarized in this section can be found in the detailed task descriptions in Section 5.

One additional In-Flight simulation task was performed. This effort was not covered under this contract, but utilized the VISTA supplied by the AFRL in cooperation with AFTPS under a Cooperative Research and Development Agreement (CRADA) with Lockheed Martin Tactical Aircraft Systems (LMTAS). As part of risk reduction activities for the development of the a next-generation fighter cockpit for future aircraft, such as the Joint Strike Fighter (JSF) aircraft, LMTAS requested to use the VISTA and its programmable display system (PDS) capabilities for the demonstration and evaluation of a Virtual Head-Up Display (HUD) concept.

Nine test pilot and other pilot training tasks were performed. These were primarily in support of the AFTPS curriculum flights, but also included tasks to demonstrate VISTA's capabilities for pilots from NASA, the F-22 Flight Test Squadron, Switzerland, South Africa, Air National Guard, and train AFTPS staff instructor pilots to become VISTA safety pilots.

VISTA improvements accounted for three direct tasks. Two tasks made significant improvements in VISTA capabilities. The primary improvement was the replacement of the out-dated Hawk computers and installation of VME Intel Pentium-based CPUs, associated I/O, and flash memory. This brought the VSS computers up to date and significantly increased VISTA's computing capacity. Another significant improvement covered the development of the VISTA VSS Software Development and Test Station, or "Hotbench". This system is composed of two separate VME-based computers with one computer system emulating the primary VSS1 computer and the other computer system emulating the necessary core-F-16 avionics. This system allowed testing of the actual VSS Operational Flight Program and other interfaces prior to loading on the actual aircraft. Another VISTA task covered the installation of a VSS electric control of the throttle on the Pratt & Whitney PW-229 engine. This was the Improved Digital Electronic Engine Control (IDEEC). The PW-229 engine was replaced with a General Electric F110 engine before this capability could be used. In addition, a few other improvements were implemented as part of the basic operational tasks. To increase the utility of VISTA for the training mission at the AFTPS, the VSS and PDS were integrated with a Maverick and AIM-9X missile stores. This allowed these weapon systems to be used in curriculum flights and be integrated with the HUD and HMD.

A few minor improvements were made in TIFS on operational and maintenance tasks. These included a new instrument panel frame in the simulation cockpit and a new compass and HSI for the safety cockpit. The new instrument panel frame was installed to take advantage of the new simulation cockpit configuration built for the NASA Synthetic Vision programs and will

allow displays for future programs to be easily installed. The new compass and HSI replaced obsolete navigation equipment in the safety cockpit.

Five aircraft and system support tasks were performed. These were all related to VISTA operations. They included two tasks for updating of original Lockheed Martin drawing files, a task to update the aircraft structural integrity program, and two tasks for basic operational support and transition of the VISTA to AFTPS at Edwards AFB.

Six direct maintenance tasks were performed. VISTA maintenance tasks included one for the Programmable Display System (PDS) which consisted of purchasing spares for the Helmet Mounted Display (HMD) and having PDS-related support performed by its manufacturer. Another VISTA maintenance task purchased spares for the VSS including computer, feel system, and voice recognition system spares. In addition a 300-hour phase inspection was covered by a specific task. The TIFS had three direct maintenance tasks that covered a phase and extended interval inspection.

In addition, one non-aircraft-related task was performed on this contract. It was an AFRL/VA sponsored task which covered the fabrication of a wind tunnel Magneto-Aerodynamic model by GDAIS for testing in AFRL's Mach 6 High Reynolds number facility.

1.1.2 Summary of Flight Activity.

Flight activity for the two AFRL In-Flight simulator aircraft for each year of the contract is shown on Table 3. A total of 571.4 hours were flown on the two aircraft. Note that VISTA was flown for only three years on the contract and the TIFS for two years.

Table 3

SUMMARY OF FLIGHT ACTIVITY BY AIRCRAFT AND YEAR

	VISTA		TIFS	
Year	**Flt-Hrs**	**Flights**	**Flt-Hrs**	**Flights**
1999	64.4	47	121.8	84
2000	155.7	111	0.0	0
2001	229.5	176	Off contract	
2002	Off contract		Off contract	
2003	Off contract		Off contract	
2004	Off contract		Off contract	
TOTAL	**449.6**	**334**	**121.8**	**84**

The total flight time for the In-Flight simulator aircraft shown above compares with 220 hours for the NT-33A, 336 hours for VISTA, and 614 hours for the TIFS on the previous five-year (1994-1999) contract. A total of 1,170 hours were flown on the previous contract.

The flight activity on VISTA steadily increased through the years on this contract and since its transfer to the AFTPS, has continued to be heavily used there for curriculum flights, Test Management Projects, and research activities. The use of the TIFS on this contract ended

after the NASA-sponsored High Speed Civil Transport and Enhanced/Synthetic Visibility projects which were completed in 1999. Recently, under the Cooperative Research and Development Agreement, TIFS flight activity has resumed with the AFRL-sponsored X-40A Integrated Adaptive Guidance and Control evaluations. Further flight activities are in the planning phase for avionics tests and other research programs.

2. Management and Support

2.1 On this task order contract, each task added to the contract contributed a percentage of its budget toward the contract administration effort. This effort consisted of management of the overall contract, management of the specific tasks, scheduling of the aircraft, pilot scheduling, planning for future projects, monthly reporting, MILSTRIP parts requisitioning, property and inventory control, liaison with AFRL and other government agencies, annual Air Force inspections, and computer software license renewals. Each task on this contract was assigned a project engineer in charge of the technical effort for that task. The project engineers for each specific task are listed under the individual task descriptions in Section 4.

Total facility support funding on this contract was approximately $860K, or about 9%, of the total funding. Since each task was assessed a percentage of the overall cost of the task, this contract and the AFRL In-Flight simulators were supported by the task sponsors rather than by AFRL directly.

In addition to day to day management of this contract, a significant amount of effort was devoted to transitioning VISTA and TIFS off this AFRL contract to other operational concepts. Most of this activity was covered under specific transition tasks.

Early in 1999 AFRL made the decision to discontinue operating test aircraft. This essentially required removing these aircraft from this contract. The AFRL In-Flight Simulation Program Office and GDAIS worked diligently over the following two years to preserve these national assets so that they could continue to function as sophisticated flight research and training aircraft, but not under the control of AFRL.

Early in this process, the concept of giving or selling these aircraft to GDAIS was investigated. It was determined that this would not be possible due to policy and financial reasons. Next, the AFRL IFS program office advanced the idea of turning the two aircraft over to a Cooperative Research and Development Agreement (CRADA) and having GDAIS assume all responsibility for aircraft operations. Under terms of a CRADA, both the government and a private organization (the collaborator) share in some endeavor to the benefit of both parties. For these aircraft CRADAs, the government would still own the aircraft but give them to GDAIS for operations. GDAIS, the collaborator, would assume all operational responsibility. This would include GDAIS re-licensing these aircraft with the FAA in the Experimental category, providing liability insurance, and all other operational support. AFRL would have oversight into GDAIS operations, but would not be responsible for approving normal activities. The FAA would be the

overseeing government agency. This is very similar to the way in which GDAIS operates its IFS Learjets, except GDAIS owns them.

Over the next year and a half, the CRADA was pursued for the TIFS, and after many discussions, meetings, and negotiations with AFRL, FAA, DCMA, and the Government Flight Representative (GFR), an agreement was reached. It was signed by GDAIS and AFRL on 24 November 1999. The TIFS was not assigned to the CRADA until 18 July 2000, when the Air Staff officially approved the transfer. Since being assigned to the CRADA, GDAIS has re-licensed the TIFS with the FAA with registration number: N793VS. It received its airworthiness certificate in January 2001, and resumed flight operations in early 2003.

VISTA's transition off this contract did not follow the same path. Many difficulties arose in trying to turn VISTA's operations completely over to GDAIS under a CRADA. The FAA was willing to re-license it, but liability insurance could not be obtained for a test F-16. It was also impossible to have the Air Force assume liability when they did not have full control of its operations. By early 2000, it was determined that the CRADA path would not succeed. At this time the AFTPS, which was a primary user of the aircraft, started developing plans to assume control of the VISTA, base it at Edwards AFB, and have GDAIS continue to operate it there. Throughout the year many meetings were held with AFRL and AFTPS to determine how the transfer would be made. By the end of the Summer of 2000, plans for the transition were complete. The VISTA was transferred to Edwards AFB in October 2000, where it has since remained. GDAIS established an operations office at Edwards and began operations with a maintenance crew of three (later expanded to a crew of five), an on-site manager/pilot, and support from Buffalo personnel for maintenance and engineering. It took over a year from this point to complete all the necessary contract revisions, establishing operational procedures, and shipping support equipment and spares. The VISTA continued to be operated under this contract through 2001 until January 2002 when it was officially transferred to the new operations contract under AFTPS (F04611-02-D-0007).

3. Maintenance

The costs of aircraft inspections, unscheduled maintenance, technical order library updates, VSS calibration and maintenance, quality assurance functions, life support equipment maintenance and inspections, ground support equipment calibration and maintenance, and contract-owned ground computer software and hardware support were paid for by a maintenance account set up for each aircraft. Projects that utilized each aircraft contributed funds to support that maintenance account based on the flight hours actually flown by a project. In addition, funding was received from AFRL and AFTPS to supplement these accounts. Over the period when the aircraft were on this contract (VISTA: March 1999 – December 2001) and (TIFS: March 1999 – July 2000) approximately $780,000 was spent on VISTA maintenance and $420,000 on TIFS maintenance. This does not include maintenance paid by AFTPS during operations at Edwards AFB from October 2000 through 2001, when the aircraft was permanently based there.

Throughout the contract, routine maintenance was performed on both aircraft. This included pre- and post-flight checks, minor system repairs such as electrical and mechanical components, and VSS maintenance.

Other maintenance items of note performed on VISTA included:

- Replacement of a VSS cooling fan
- Engine inspections and TCTO compliance
- 300-Hour phase inspection
- Side-stick and center-stick repairs
- Fuel cell repairs
- Replace canopy actuator
- DFLCC repairs
- HMD repairs

Other maintenance items of note performed on TIFS included:

- Phase 22 & 23 (100-hour) inspection
- Extended Interval 03 inspection (leading edges & fuel cells)
- Nose landing gear inspection
- Engine inspections

4. Task Descriptions

When tasks were assigned to this contract a task order number was issued from the contracts office at Wright Patterson AFB. The task order number included the fiscal year that it was assigned and a sequential number for that year. This task order authorized GDAIS to perform a particular In-Flight simulation or research investigation project. Brief descriptions of all the tasks authorized on contract F33615-99-C-3000 are provided in this section. As these tasks were authorized in a sequential manner, the task descriptions give a history of the utilization of the aircraft over the duration of this contract. These task descriptions include a brief summary of the project, the funding, and the name of the project engineer.

Task 99-01 VISTA Computer Upgrade
Project Engineer: Tom Joseph
Funding: $658,556

This task, "Complete VISTA Computer Upgrade Phase II (Hawk Replacement)", was the final portion of a multi-phase effort to upgrade the Variable Stability System (VSS) computers on-board the VISTA. In 1997, the United States Air Force (USAF) Joint Strike Fighter (JSF) Program Office funded the replacement of the VISTA Feel System Computer (FSC) with a more powerful ½ Air Transport Rack (ATR) Versa Modular European (VME) Pentium-based processor (task on previous contract). Under the Thrust Vectoring Upgrade Program in 1998,

AFRL funded the second phase of this effort to replace the Hawk Computers with similar VME-based processors contained in 2 full ATR size enclosures. These enclosures were placed where Hawks 2 and 3 currently reside (in the Ammo Bay). Hawk 1 and the I/O expansion unit are located in the dorsal and will be permanently removed. Present wiring routed to Hawk 1 and the I/O expansion unit were re-routed to the new computers. These new computers were identically configured with a 233 MHz Intel Pentium primary processor and provided the capability to support a co-processor. Analog (A/D, D/A, and Discrete) and digital (1553) interface cards were also added. Each chassis has spare I/O capacity (7 out of 15 slots available for future expansion). Flash memory on the CPU cards is as a primary boot device, and a Kaman Flash card SCSI interface was also added as a mass storage device. The previous VSS software, written primarily in Ada 83, was rehosted to Ada 95 and integrated into a single executive. I/O drivers were re-written using prototypes developed during the FSC upgrade.

Task 99-02 VISTA 711 Drawings Transfer
Project Engineer: John Stolfo
Funding: $112,538

The "711" drawing series was originated by Lockheed Martin (LMTAS) for the VISTA program to segregate all drawings associated with this one-of-a-kind modification of an F-16. When any F-16 electrical, mechanical, hydraulic, pneumatic, crew station, instrumentation, etc. drawing required a VISTA unique update, a 711 version was created. All VISTA unique installations required new drawings that were generated as 711 drawing files. This task covered the continuing effort to convert a majority of these 711 drawings into files that could be accessed and updated by GDAIS. The purchase of a CATIA workstation, associated software, specialized training and delivery all LMTAS 711 CADAM and CATIA based drawing files was accomplished on the previous 5-year operations contract. This task resolved outstanding problems with the software files, completed conversion of the file management procedures to ISO-9001 compliance, and allowed user time on the workstation for proficiency. With the completion of this task GDAIS had the ability to update and maintain these drawings.

Task 99-03 VISTA AFTPS Test Management Project Spring '99 – HAVE Track
Project Engineer: Russ Easter
Funding: $269,823

This task covered the use of the VISTA for an Air Force Test Pilot School Test Management Project (TMP) for Class 98-B in the Spring of 1999. The general objective of this TMP called HAVE Track was to investigate the use of a flight test Head-up Display (HUD) to develop quantitative analysis methods for predicting operational handling qualities. Two HUD tracking tasks were provided. The first was referred to as the "MIL-STD" HUD task (as in MIL-STD-1797A). It was the same task used in the HAVE Filter TMP in Fall 1998. It consisted of a fixed (depressible) aiming symbol and a target symbol programmed to provide time-varying pitch and roll tracking. The second tracking task was referred to as the "realistic" task. It was intended to provide a target that simulated the motion of an actual T-38 target. A total of 13 flights and 16.0 flight-hours were flown.

Task 99-04 TIFS NASA XVS Preliminary Design
Project Engineer: Paul Schifferle
Funding: $50,000

As part of the joint industry-NASA High Speed Research (HSR) program developing the technology for an economically viable next-generation commercial supersonic transport aircraft - the High Speed Civil Transport (HSCT), the TIFS was used for flight evaluations of the External Visibility System (XVS) concept and how the pilot, XVS, and sensors integrate in an actual flight environment. The XVS provided the pilot with forward visibility equivalent to current generation transport aircraft, without drooping the HSCT nose section by electronic display media. A short series of flights were flown in 1996 to investigate field-of-view requirements for an XVS by using window masking. For a more thorough investigation of the XVS concept, the TIFS cockpit had to be extensively modified to accommodate the required sensors and displays. Another task on the previous 5-year contract covered the design, fabrication, installation, and ground and flight checkout of the primary set of cockpit modifications. This task covered Phase 3A, the preliminary design, feasibility and trade studies of modifications to the TIFS aircraft to support another series of XVS evaluations, the so-called "FL5" flight tests. The FL5 flight tests were intended to evaluate advances in state-of-the-art XVS concepts and took place later in 1999 (see Tasks 99-09 and 99-13). Among the advances evaluated was the use of a flat screen projection system in place of the High Definition Television (HDTV) monitor used in the previous FL4 flight tests.

Task 99-05 TIFS Deferred Maintenance (NASA GFC Flights)
Project Engineer: Norman Weingarten
Funding: $50,000

During the previous Airborne Simulation and Research Investigations contract (F33615-93-C-3608), NASA had requested GDAIS to continue flight operations in December of 1998 and January of 1999 on the High Speed Research (HSR) Guidance and Flight Control (GFC) evaluations – the HSR/TIFS.3 flights. These flights were originally covered on the previous contract (under its Task 98-11. As significant complications in the integration of new simulation models and equipment were encountered, there were not enough funds to complete all of the desired flights. A task plan was written for the amount of $50,000 to cover the additional effort. NASA was not able to transfer the funding to AFRL in time to get funds applied to the old contract. The Air Force, however, approved the additional effort to complete the flights and authorized GDAIS to use Maintenance and Facility Support funds in the amount of $50,000 from the HSR/TIFS.3 evaluation task from the previous contract to pay for this effort. With the beginning of this new contract (F33615-99-C-3000), NASA's funding was added to the contract to replenish the Maintenance and Facility Support funds so deferred maintenance and facility support could be performed.

Task 99-06 TIFS Deferred Maintenance (NASA IFOV Flights)
Project Engineer: Norman Weingarten
Funding: $63,228

During the previous Airborne Simulation and Research Investigations contract (F33615-93-C-3608), NASA had requested GDAIS to install an In-Board Field-of-View (IFOV) upgraded display for the High Speed Civil Transport (HSCT) External Visibility System (XVS) evaluations in January of 1999. A task plan was written in the amount of $63,228 to cover that effort. NASA was not able to transfer the funding to AFRL in time to get the funds applied to the old contract. The Air Force, however, approved the IFOV task and authorized GDAIS to transfer Maintenance and Facility Support funds in the amount of $63,228 from the XVS Evaluation task on the previous contract to the IFOV task. A revised task plan for the XVS evaluations on the previous contract reduced the funding for the XVS evaluation task by $63,228. With the beginning of this new contract (F33615-99-C-3000), NASA's funding was added to the contract to replenish the Maintenance and Facility Support funds so deferred maintenance and facility support could be performed.

Task 99-07 VISTA System Integration (Electric Throttle)
Project Engineer: Mark Bergum
Funding: $453,473

This task was a continuation of the System Integration Task Plan for VISTA Thrust Vectoring Upgrade under the previous operating contract (F33615-93-C-3608). Under this previous contract task, GDAIS began work to integrate the Improved Digital Electronic Engine Control (IDEEC) with the Variable Stability System (VSS). This would have allowed VSS control of the electric throttle command in the Pratt & Whitney PW-229 engine until funding was available to integrate thrust vectoring and engine control through the Digital Flight Control Computer (DFLCC) or by other means. Integration with the VSS was designed to allow reversion to thrust and vectoring control to meet the goals of programmable Thrust Vectoring. The new IDEEC OFP contained maneuver accommodation logic and software to support thrust vectoring. To complete the electric throttle integration task, the following tasks were identified:

- Reinstallation of the loaner IDEEC to support ground engine run.
- Prepare EMI test procedure.
- Recording and telemetry data checks.
- Hangar tests for electric throttle command functionality and VSS / IDEEC interfaces.
- VISTA Ground Checks.
- Documentation.
- The production IDEEC was to be reinstalled for VISTA flight testing at Edwards Air Force.

After all of the funds were expended and most of the work had been completed, The Air

Force returned the PW-229 engine to Pratt & Whitney, reinstalled the General Electric engine, and work was suspended on this task.

Task 99-08 VISTA Boeing JSF Simulation Preparation
Project Engineer: Tom Joseph
Funding: $20,084

This task originally was to cover the In-Flight simulation and evaluation of the Boeing Joint Strike Fighter (JSF) multi-role fighter aircraft. The work started on the previous operations contract. This in-flight simulation program was to utilize the VISTA. The objective of the simulation was to evaluate the flying qualities of the Boeing JSF in the Powered Approach and the Up-and-Away flight conditions in support of the control law development and evaluation. Soon after this contract was started, Boeing decided not to use In-Flight simulation in their development program, and this task was suspended.

Task 99-09 TIFS NASA XVS Modifications & Flights FY99
Project Engineer: Randall Bailey
Funding: $874,153

As part of the joint industry-NASA High Speed Research (HSR) program developing the technology for an economically viable next-generation commercial supersonic transport aircraft - the High Speed Civil Transport (HSCT), the TIFS was used for flight evaluations of the External Visibility System (XVS) concept and how the pilot, XVS, and sensors integrate in an actual flight environment. The XVS provided the pilot with forward visibility equivalent to current generation transport aircraft, without drooping the HSCT nose section by electronic display media. A short series of flights were flown in 1996 to investigate field-of-view requirements for an XVS by using window masking. For a more thorough investigation of the XVS concept, the TIFS cockpit had to be extensively modified to accommodate the required sensors and displays. Tasks on the previous 5-year contract and this contract covered the design, fabrication, installation, and ground and flight checkout of the cockpit modifications. These modifications included the installation of a three-camera HDTV camera and projector system (which replaced the single-camera HDTV monitor) in the simulation cockpit. Minor modifications were also made to other equipment in the simulation cockpit and aft cabin. The primary modification made for this current task was the installation of a flat screen projection system in place of the High Definition Television (HDTV) monitor used in the previous flight tests. Three camera views were projected on the screen: upper and lower halves with a higher resolution insert in the center of the screen. The flight activity took place at the NASA Langley Research Center and Wallops Flight Facility. A total of 21 flights and 36.0 flight-hours were flown.

Task 99-10 TIFS NASA HSCT GFC Support FY99
Project Engineer: Randall Bailey
Funding: $216,000

A critical component of the joint industry-NASA High Speed Research (HSR) program work was the development of the technology required in the areas of Guidance and Flight Control (GFC) for safe and economical HSCT flight. GDAIS continued to be a participant, with NASA and other industry partners, in the HSR Guidance and Flight Control (GFC) Integrated Technology Development (ITD) team and in the work being performed under the guidance and direction of this group. This task continued GDAIS activities, started under the previous operations contract, to assist the GFC HSR program ITD for the period February 1999 through September 1999. This work included the analysis and reporting of the TIFS HSR flight test programs, and other HSR GFC activities including: requirements document update, ground-based simulation studies, GFC-specific administrative and managerial tasks such as monthly progress reports, task summaries, technical review of GFC-partner activities, and miscellaneous technical information gathering tasks, and data analysis and reporting.

Task 99-11 VISTA Aircraft Structural Integrity Program
Project Engineer: Paul Schifferle
Funding: $881,258

The standard F-16C/D Fleet Management Methodology and Structural Management Process is not truly applicable to the VISTA F-16. In order to maintain the structure and provide for the intended service life, a new Structural Management Program (SMP) was needed for the VISTA that took into account the unique flight characteristics of the aircraft. To this end, a purchase order agreement with Lockheed Martin Tactical Aircraft Systems (LMTAS) to develop such a program was made. This task covered the development of the Aircraft Structural Integrity Program (ASIP) by LMTAS as well as a one-time special inspection of LMTAS-specified airframe structural control points by GDAIS. LMTAS's ASIP effort resulted in the preparation of a summary report comparing the VISTA Crash Survivable Flight Data Recorder (CSFDR) flight parameters recorded to existing usage USAF Block 30 aircraft and other similar airframes. Based on the usage comparisons, LMTAS made a conservative estimate on the suitability of the inspection intervals required for continued airframe integrity. The structural integrity of the VISTA will be maintained through the use of this updated ASIP that uses flight usage parameters stored on the CFSDR and the results of inspections of critical structural locations on the airframe (so-called "control points") to determine the next inspection interval.

Task 99-12 Wind Tunnel Magneto-Aerodynamics Model
Project Engineer: Ken Chadwick
Funding: $93,316

This task covered a non-aircraft related AFRL/VA study: fabrication of a wind tunnel Magneto-Aerodynamic model by GDAIS for testing in AFRL's Mach 6 High Reynolds number facility. GDAIS designed and fabricated a sphere/cylinder test model for these tests. This test model had a nominal 2-inch-diameter spherical nose with a cylindrical after-body. The spherical nose was fabricated such that it was permeable by a magnetic field of sufficient strength to meet the performance requirements specified by AFRL/VA. In addition, the test model design had the capability of delivering plasma through a center-axis channel to the stagnation region of the spherical nose. The required mating of this channel to the plasma generating system was closely coordinated with AFRL. Integral to the test model design was a magnetic field coil which produced the desired steady-state field at a strength (0.5 Tesla) of sufficient duration (10 to 15 seconds) in order to make the aerodynamic measurements. The power supply specifications required to meet the necessary field strength were determined and the type of source and availability was coordinated with AFRL.

Task 99-13 TIFS NASA Synthetic Vision Tests
Project Engineer: Randall Bailey
Funding: $379,265

For the NASA High Speed Research External Visibility System (XVS) "FL5" flight test (Task 99-09), the TIFS aircraft was outfitted with a large forward-facing projection display system in the evaluation cockpit. In addition, a Silicon Graphics, Inc (SGI) Onyx/2 computer was installed in the TIFS cabin with associated scan converters and High Definition Television (HDTV) video cameras and recorders. With this set-up, the TIFS provided an ideal flight test vehicle to test Synthetic Vision (SV) concepts for the NASA Aviation Safety Program. The objective of the Aviation Safety Program Synthetic Vision element was to provide cost-effective synthetic/enhanced vision displays using worldwide terrain databases and Global Positioning System (GPS) navigation to eliminate visibility-induced errors for all aircraft. The displays are intended to enhance situational awareness and tactical flight path management in low visibility weather conditions. This task performed a flight test program, the so-called "SV1" flight test, conducted immediately following the conclusion of the HSR XVS FL5 flight test for the evaluation of a synthetic display concept. These additional flights used the same XVS equipment installed for the HSCT program and was flown at Asheville, NC and Harrisburg, PA, where the rugged terrain was displayed on the synthetic vision system driven by cameras and computer generated imagery. A total of 19 flights and 19.9 flight-hours were flown.

Task 99-14 VISTA Operations Support
Project Engineer: John Ball
Funding: $414,575

In an effort to reduce the variation in cost per hour and to lower the cost to customers (especially customers with low budgets such as the AFTPS), funding was received from AFRL to cover much of the fixed costs associated with operation of the VISTA aircraft during 1999 and 2000. This effort covered: Functional Check Flights (FCFs) including variable stability system checks and calibrations after airframe, engine, or VSS maintenance; Safety Pilot proficiency and checkrides; airframe and VSS maintenance including: Technical Order (TO) library administration, life-support maintenance (parachutes, flight helmets, etc); ground equipment maintenance; unscheduled repairs such as a cracked wing bulkhead and an engine change; technical support by LMTAS, General Electric, and Pratt and Whitney; and logistics administration.

Task 99-15 VISTA AFTPS Demonstration Flights Fall '99
Project Engineer: Tom Landers
Funding: $577,678

This task covered the VISTA training session for the AFTPS during September and October 1999. At that time, the last previous training session using VISTA for at the AFTPS was completed in March 1996. At that time the aircraft was removed from service to begin modification of hardware to give VISTA a thrust vectoring capability. When that effort was suspended, training sessions at AFTPS resumed. AFRL underwrote some of the costs allowing this program to resume. Demonstration flights for the test pilots in training emphasized handling qualities issues with some system demonstrations included. For the flight test engineers in training, the emphasis of the demonstration flights was on aircraft experimental systems but with some handling quality demonstrations included. Representative handling qualities topics demonstrated included: actuator rate limiting, direct lift control, use of programmed test inputs, effect of type of controller (sidestick or center stick) on handling qualities, and characteristics of the unaugmented basic aircraft. Experimental aircraft systems demonstrated included: a voice recognition system, a programmable Head Up Display (HUD), a Helmet Mounted Display (HMD), and an automatic test input generator. Sorties were flown by 22 students and 3 staff pilots. A total of 30 flights and 43.5 flight-hours were flown.

Task 00-01 VISTA AFTPS Demonstration Flights Spring '00
Project Engineer: Tom Joseph
Funding: $419,568

This task covered the continuation of curriculum demonstration sorties for the AFTPS. For this Spring 2000 session, demonstration flights for the test pilots in training emphasized handling qualities issues with some system demonstrations included. For the flight test engineers in training, the emphasis of the demonstration flights was on aircraft experimental systems but with some handling quality demonstrations included. Representative handling qualities topics

demonstrated included: actuator rate limiting, direct lift control, use of programmed test inputs, effect of type of controller (sidestick or center stick) on handling qualities, and characteristics of the unaugmented basic aircraft. Experimental aircraft systems demonstrated included: a voice recognition system, a programmable Head Up Display (HUD), a Helmet Mounted Display (HMD), and an automatic test input generator. Sorties were flown by 11 students, 3 staff pilots, and 2 F-16 flight test squadron pilots. A total of 16 flights and 18.4 flight-hours were flown.

Task 00-02 VISTA 711 Drawings
Project Engineer: John Stolfo
Funding: $312,324

This task was a continuation of Task 99-02 and continued with the update of VISTA-unique "711" drawings. This task identified the drawings that still required updating and completed the transfer of LMTAS drawing files. The drawings required updates to document new hardware installations (feel system computer and Hawk computer replacements), aircraft repairs (bulkhead reinforcements, installation of doubler plates), improvements (rerouting of Controlex throttle cable), and compliance with TCTOs. CATIA drawing files included 2D and 3D files of structural installation changes to the FCS computer, VSS#1 computer, and VSS#2 computer. CADAM CATIA Drafting (CCD) files included 2D Instrumentation Group hardware installation drawings. A majority (160 out of 193) of the VISTA electrical drawings were also updated as CCD drawing files.

Task 00-03 VISTA Hotbench Development
Project Engineer: Tom Joseph
Funding: $325,747

This task covered the development of the VISTA VSS Software Development and Test Station, or "Hotbench". This system is composed of two separate VME-based computers with one computer system emulating the primary VSS1 computer and the other computer system emulating the necessary core-F-16 avionics. This system allows testing of the actual VSS Operational Flight Program (OFP). This task covered the effort required to develop, integrate, checkout, and set up the VISTA hotbench system in GDAIS' Buffalo facility. This Hotbench uses a Pentium VME-based architecture similar to what is used for the primary VSS computers installed in VISTA. The Hotbench is composed of two 20 slot VME computer systems. The first system, designated the VSS Computer System (VSSC), emulates the VSS1 computer and contains an exact commercial equivalent VME cards as the VSS1 rugged computer installed in VISTA. By using the exact commercial equivalent VME cards, the VSS OFP is able to run on the VSSC without modification. The second system, designated the Ground Simulation Computer (GSC), contains similar VME cards as the VSS1 computer to minimize driver development and emulates the necessary core-F16 avionics to allow the VSS to engage and produce time history data. An interface cable connects the GSC with the VSSC. This interface cable connects the required digital and analog I/O between the two systems. Another interface cable can connect the GSC to the VISTA aircraft to allow the GSC to perform as a high fidelity ground simulation computer for actual on-aircraft checkout.

The capabilities of the VSS SDTS are:

- The VSSC runs the exact VSS flight OFP without modification. This allows functional and timing checks to be performed.
- The VSSC loads in the VSS OFP from a Raymond SCSI Data Transfer System (DTS) flash memory card identical to how the OFP is loaded using the aircraft.
- The GSC emulates the VSS Multi-Function Display (MFD) pages and the VSS Up-Front Controls (UFC) Data Entry Display (DED). This allows a test engineer to verify the pilot interface and configuration file load.
- The GSC emulates the necessary DFLCC engage interface and minimal flight control law to allow for VSS engagement.
- The GSC contains a high fidelity 6 Degree-Of-Freedom (6DOF) simulation of the latest known VISTA aerodynamic properties. This 6DOF simulation is able to be connected directly to the VISTA aircraft.
- The GSC contains an emulation of the VSS Control Panel Chassis (CPC) to allow for selection and de-selection of VSS functions.

Task 00-04 VISTA F-22 Pilot Demonstrations
Project Engineer: Tom Joseph
Funding: $44,183

This task covered the effort required to provide advanced system demonstration flights and ground simulation for the 411th Flight Test Squadron's F-22 test pilots using the VISTA at Edwards AFB during the Spring of 2000. VISTA was at Edwards at this time to support the AFTPS. The VISTA systems utilized during these flights included the Variable Stability System (VSS), the Programmable Display System (PDS), and the Voice Recognition System (VRS). The VISTA simulated and demonstrated a wide range of handling quality test points. The PDS provided both a programmable Heads Up Display (HUD) and Helmet Mounted Display (HMD) that demonstrated symbology variations as well as off bore-sight targeting. The VRS allowed the evaluation pilots to control PDS functions and request aircraft information using voice commands without looking into the cockpit or separate switch activation. All of these systems were demonstrated in-flight and on the ground using VISTA's unique ground simulation capability. A total of 3 flights and 3.6 flight-hours were flown.

Task 00-05 Not Assigned

Task 00-06 VISTA NASA Pilot Demonstrations
Project Engineer: Tom Joseph
Funding: $27,168

This task covered the effort required to provide advanced system demonstration flights and ground simulation for two test pilots from the NASA Dryden Flight Test Center using the VISTA at Edwards AFB during the Spring and Fall of 2000. VISTA was at Edwards at this time to support the AFTPS. The VISTA systems utilized during these flights included the Variable

Stability System (VSS), the Programmable Display System (PDS), and the Voice Recognition System (VRS). The VISTA simulated and demonstrated a wide range of handling quality test points. The PDS provided both a programmable Heads-Up Display (HUD) and Helmet Mounted Display (HMD) that demonstrated symbology variations as well as off bore-sight targeting. The VRS allowed the evaluation pilots to control PDS functions and request aircraft information using voice commands without looking into the cockpit or separate switch activation. All of these systems were demonstrated in-flight and on the ground using VISTA's unique ground simulation capability. A total of 2 flights and 2.7 flight-hours were flown.

Task 00-07 Not Assigned

Task 00-08 VISTA AFTPS Demonstration Flights Summer '00
Project Engineer: Andrew Markofski
Funding: $169,365

This task covered the continuation of curriculum demonstration sorties for the AFTPS. For this Summer 2000 session, demonstration flights for the test pilots in training emphasized handling qualities issues with some system demonstrations included. For the flight test engineers in training, the emphasis of the demonstration flights was on aircraft experimental systems but with some handling quality demonstrations included. Representative handling qualities topics demonstrated included: actuator rate limiting, direct lift control, use of programmed test inputs, effect of type of controller (side stick or center stick) on handling qualities, and characteristics of the unaugmented basic aircraft. Experimental aircraft systems demonstrated included: a voice recognition system, a programmable Head Up Display (HUD), a Helmet Mounted Display (HMD), and an automatic test input generator. In addition to the student demonstration flights, there were a few AFTPS staff training flights and additional ground familiarization to help prepare the AFTPS staff for their eventual greater involvement in the operations of VISTA. Sorties were flown by 10 students and 6 staff pilots. A total of 16 flights and 20.8 flight-hours were flown.

Task 00-09 Not Assigned

Task 00-10 Not Assigned

Task 00-11 VISTA Programmable Display System Maintenance
Project Engineer: Tom Landers
Funding: 68,159

VISTA is equipped with a Programmable Display System (PDS). The PDS provides a programmable Head-Up Display (HUD) and Helmet-Mounted Display (HMD) capability for the Evaluation Pilot. The PDS is unique to the VISTA and has proven to be an invaluable asset for the VISTA mission. This task provided funding for critical spare parts acquisition as well as on-site support, troubleshooting, and software upgrades from BAE Systems, the manufacturer of the PDS. This work ensured the functionality of the PDS from 2000-2003. Under this task:

- BAE Systems provided the following spares for the PDS: replacement display visors, cathode ray tube, high voltage power supply unit, miscellaneous wear-and-tear items and parts (such as chin straps, nap straps, ear cups, bayonets, and bayonet receivers).
- BAE Systems maintained the PDS equipment in operational order for a period of three years.
- BAE Systems provided software support for the PDS.
- GDAIS procured a spared HMD camera

Task 00-12 VISTA AFTPS Syllabus Development
Project Engineer: Tom Landers
Funding: $119,191

By 2000, the VISTA had undergone several major upgrades, including the introduction of a programmable Head-Up Display (HUD), programmable Helmet-Mounted Display (HMD), and voice recognition system (VRS) capabilities. During the VISTA deployments to Edwards AFB in 1999 and 2000, these advanced, state-of-the-art systems were demonstrated to the AFTPS staff and students. The impressive capabilities of VISTA were immediately recognized and an increased role in the TPS syllabus was desired by all who witnessed the demonstrations. These advanced systems demonstrations were developed as an adjunct to the development of these systems, rather than being produced specifically with training or testing in mind. The objective of this task was to incorporate these new features into the AFTPS curriculum. The effort included an initial study of how these VISTA enhanced capabilities could be tailored to meet AFTPS testing and training needs. The objective was to make the VISTA flights an integral part of the AFTPS curriculum by enhancing the training provided to the students and by providing advanced systems capabilities for testing and demonstration at the Air Force Flight Test Center. After this study, GDAIS implemented these mutually agreed upon changes to the VISTA demonstration profile and to the VISTA software and verified that these changes met these objectives. Following implementation and ground checkout of the VISTA capabilities refinements, 8 flights were flown at the AFTPS for checkout of the refined capabilities and assessment of whether these capabilities would adequately meet the training and testing objectives of AFTPS. A total of 8 flights and 10.8 flight-hours were flown.

Task 00-13 VISTA AFTPS Instructor Pilot Training
Project Engineer: Karl Hutchinson
Funding: $85,367

The AFTPS required an increase use of the VISTA at the school to support more of their curriculum flights. To support these more frequent operations, training needed to be provided to AFTPS staff instructors and a GDAIS test pilot stationed at Edwards AFB to be VISTA Systems instructor pilots. This task covered the training of these pilots. GDAIS provided training for three AFTPS instructor pilots and a GDAIS test pilot towards becoming VISTA Systems Demo instructor pilots. The training was tailored to the VISTA/AFTPS Systems Demonstration flight sorties rather than the much more complicated Variable Stability sorties. Training took place at Edwards AFB, and consisted of classroom instruction, on-aircraft cockpit familiarization, and training flights. A total of 18 flights and 24.1 flight-hours were flown. Three AFTPS staff pilots and one GDAIS pilot were trained under this task. Other pilots were later trained on the basic AFTPS operational task using the training procedures developed under this task.

Task 00-14 Not Assigned

Task 00-15 VISTA VSS Spares
Project Engineer: Tom Landers
Funding: $326,703

A full complement of spare Variable Stability System (VSS) components was not obtained during the VISTA development or subsequent system upgrades because of cost constraints. This task identified and procured spare VSS components required for long-term support of the VISTA. Spare components were required for the following: the new VME-based VSS computer system; servoed throttle; side stick; and the voice recognition system (VRS). Items procured were:

- Host CPU
- Flash Memory and Spare Cards
- Analog I/O: (A/D, D/A, & Discretes)
- 1553 I/O Card
- Throttle Electronic Unit
- Side Stick Actuators - Pitch & Roll
- Side Stick Load Cell
- Quad RVDT
- Verbex VRS

Task 00-16 VISTA 300-Hour Inspection & Other Repairs
Project Engineer: Norman Weingarten
Funding: $144,349

During the late summer of 2000, when the VISTA operations were in transition to the AFTPS at Edwards AFB, a 300-Hour phase inspection was due on the aircraft. The VISTA was to be permanently based at Edwards AFB following the Summer AFTPS flying qualities demonstration program, which was completed in July 2000. The phase inspection was to be performed at Edwards AFB with the GDAIS AFTPS-based crew with the assistance of AFFTC LG personnel. Due to scheduling constraints on Edwards AFB, personnel and facilities and other program commitments, it was decided to return the VISTA to the GDAIS Flight Research facility in Buffalo, to perform the inspection there. This task covered the costs of the ferry, inspection, as well as repairs on VISTA's programmable variable-feel side stick. The VISTA variable-feel side stick had been in need of repair since beginning of the year. The original needle bearings were worn out, so uncommanded cross-axis inputs were sensed when inputs are commanded in the other axis. This repair replaced the pitch and roll actuators with rebuilt spare units. New sleeve bearings replaced the needle bearings, which eliminated the unintended cross-axis inputs. Parts for this repair were purchased under Task 00-15. Travel costs were also included to bring the newly hired GDAIS Edwards-based mechanic and technician from Edwards AFB to Buffalo to be trained in VISTA maintenance and operational procedures.

Task 00-17 VISTA Transition to Edwards AFB (September – December 2000)
Project Engineer: Norman Weingarten
Funding: $605,988

During the later part of 2000 when the VISTA was in the process of being transferred to the AFTPS at Edwards AFB, there was a need to fund a significant amount of effort devoted to the transition and fund operations through the end of the calendar year. This task covered the efforts of GDAIS to transition the VISTA operations that had been located at GDAIS's Flight Research facility in Buffalo, NY to AFTPS facilities at Edwards AFB. Specific tasks included: packing and shipping of VISTA spare parts and ground support equipment, costs for the full-time ground crew at Edwards AFB for the remainder of the calendar year 2000, relocation costs for moving a key Buffalo-based GDAIS employee to Edwards AFB, support from other Buffalo-based GDAIS personnel during the transition, a start-up period of operations at Edwards AFB, and other engineering support at Buffalo during the first year of operations at Edwards AFB. Efforts covered under this task included:

- Pack and Ship VISTA Spares and Support Equipment: All of the VISTA spare parts and ground support equipment that had been located at the GDAIS Flight Research facility in Buffalo, NY was shipped to Edwards AFB.
- Full-Time Ground Crew at Edwards AFB: This sub-task funded the cost of a full-time GDAIS ground crew at Edwards AFB for the time period of 3 September through 31 December 2000. This crew consisted of two mechanics and one

technician. One of the mechanics was the Buffalo-based crew chief who had been an inspector and mechanic on the VISTA for the past five years at GDAIS. His full-time presence at Edwards AFB was necessary for the successful introduction of operations of the VISTA at the new location. He was scheduled to return to Buffalo after a one-year tour of duty at Edwards AFB. The other mechanic and technician were new-hires from the Edwards AFB area. Included in the costs for this sub-task was a nominal amount for office equipment and work bench areas for these personnel. AFTPS flights flown during this period included: Have OLOP TMP, staff instructor pilot training, HMD demonstration flights for Swiss and South African pilots, demonstration flights for NASA and AFRL pilots, and syllabus development. A total of 38 flights and 51.9 flight-hours were flown during this period.

- Relocation of Key Personnel and Other Transition Support: One key GDAIS Buffalo-based employee was sent to Edwards AFB to support the operations at the AFTPS. He was an aircraft crew chief. The crew chief's assignment was for one year. The costs for his and his family's relocation and stipend in-lieu-of per diem were included in this sub-task. His labor costs were included the item above. Included in the costs for this sub-task was a nominal amount for computer tools and software for data recording and analysis for on-site engineering assistance. Labor costs for CY 2001 were covered under a separate task (Task 01-01). In addition to the full-time staff at Edwards AFB, GDAIS sent a few key individuals for short deployments to AFTPS to provide temporary on-site support and training for the Edwards-based personnel during the start-up period of Edwards operations. This included multiple two-week trips for a safety pilot, systems engineer, and senior technician.
- Engineering Support at Buffalo: After the VISTA operations were set up at AFTPS, additional engineering assistance was required at times from Buffalo-based staff on an as-needed basis. This contingency effort was for work beyond the expertise of the Edwards-based staff or for more extensive efforts requiring additional labor. Examples of this type of assistance was trouble-shooting aircraft and experimental systems problems, engineering changes, aircraft modifications, and drawing updates
- Other Miscellaneous Transition Efforts: Other miscellaneous efforts included coordination of the logistics of the VISTA transfer with AFTPS, AFRL, Government Flight Representative (GFR), and Defense Contract Management Agency (DCMA). Numerous meetings, telecons, and other discussions with the involved parties were required for a smooth transition. Coordination of procedures, oversight authority, and transfer of inventory lists and other records were performed.

Task 00-18 VISTA AFTPS Test Management Project Fall '00 – HAVE OLOP
Project Engineer: Andrew Markofski
Funding: $97,962

This task covered the use of the VISTA for an Air Force Test Pilot School Test Management Project (TMP) for Class 00-A in the Fall of 2000. The general objective of this TMP, called HAVE OLOP, was to evaluate the ability of the Open-Loop Onset Point (OLOP) criterion to predict Pilot-Induced Oscillations (PIO) in the presence of rate limiting. The test team pilots evaluated the PIO tendencies of a variety of configurations using a HUD tracking task implemented on the VISTA. These results were compared to the OLOP predictions to evaluate the ability of OLOP to predict PIO and its potential value as a design tool. This project was part of a joint Air Force Institute of Technology (AFIT)/AFTPS program. The flight test results were incorporated into a student's Masters Degree thesis titled *Prediction of Pilot-Induced Oscillations (PIO) due to Actuator Rate Limiting Using the Open-Loop Onset Point (OLOP) Criterion.* The project examined several test configurations implemented using the VISTA variable stability system (VSS). The test configurations represented four sets of longitudinal short period dynamic characteristics and a range of rate limits. Each of the four pitch configurations contained stabilizing feedback gains to augment the bare airframe dynamics. The stabilization feedback signals and the command signals were summed and fed into a rate-limited elevator actuator. The bare airframe dynamics contained one unstable configuration (worst case) while the three remaining configurations were stable but with undesirable characteristics. When not under rate-limiting all four configurations had Level 1 handling qualities, and the short period characteristics were identical. With these experimental control systems, the pilot was blind as to what configuration was being flown until rate-limiting occurred. A total of 14 flights and 18.4 flight-hours were flown.

Task 00-19 TIFS Deferred Maintenance (IPTN Flights)
Project Engineer: Norman Weingarten
Funding: $56,297

During the 1994 through 1997 time period, the TIFS was utilized by the Indonesian Aircraft Company (IPTN) to help them develop and evaluate the flight control system and flying qualities of their turbo-prop N-250 regional transport. The TIFS was flown for 31 flights consisting of 51.5 flight-hours over three phases of the evaluation effort. As part of the Memorandum of Agreement (MOA) between IPTN and the USAF (AFRL/VA), IPTN agreed to reimburse the USAF for its share of the normal and depot level maintenance incurred by this flight program. Long after the flight program was completed, it was discovered that $56,302 in maintenance funds that were transferred to AFRL for this purpose were never put on the contract for this task. At that time, the authorized end date for the expenditure of these funds had expired. IPTN extended the authorized time period for these funds to be used, so that they could be added to the current contract. This Task Plan covered the deferred maintenance that was incurred during the IPTN flight program. Though the flight program had long since been completed, maintenance on the TIFS aircraft was a continuing process, and funding from subsequent

programs covered on-going maintenance costs. These funds helped pay for a scheduled phase inspection.

Task 00-20 Not Assigned

Task 00-21 VISTA AATC Demonstration Flights
Project Engineer: Tom Landers
Funding: $19,965

In conjunction with the Air National Guard (ANG)/Air Force Reserve (AFRES) Weapons and Tactics Conference in October of 2000, the Tucson ANG/AFRES Test Center (AATC) requested that the VISTA be on site to provide a ground demonstration of its Helmet Mounted Display (HMD) to their pilots. This provided an opportunity to expose the pilots to some of the issues of HMD use in fighter aircraft. To that end, the VISTA was ferried from Edwards AFB to Tucson, AZ in conjunction with the conference and set-up for ground demonstrations. At the end of the conference, VISTA was ferried back to Edwards AFB. The VISTA Viper-IV HMD and Advanced Metal Tolerant Head Tracking systems was active during these ferry flights (with an ANG pilot as evaluation pilot) and was used to create the Virtual HUD symbology and other demonstration configurations. In addition, the Voice Recognition System (VRS) in VISTA will be employed for evaluation of advanced Pilot-Vehicle Interface (PVI) concepts. A total of 2 flights and 2.0 flight-hours were flown.

Task 01-01 VISTA AFTPS January – December 2001 Operations
Project Engineer: Tom Landers
Funding: $1,143,994

This task covered the final year of operations of the VISTA while it was stationed at the AFTPS at Edwards AFB. During this 2001 calendar year, while the VISTA was primarily used for AFTPS curriculum flights, the aircraft was in the process of being contractually transferred to the AFTPS. A new contract covering the long-term operations of the VISTA was being negotiated during this year between AFRL, AFTPS, and GDAIS. This task covered the efforts of GDAIS to continue VISTA operations at AFTPS facilities at Edwards AFB over the January – December 2001 time period. This task originally was to cover the January through April time period, but was subsequently extended through the end of 2001 with multiple task amendments. The original task covered full-time staffing (engineering test pilot, two mechanics, and one technician) at Edwards AFB for 1 January through 30 April 2001, and technical and administrative support from Buffalo-based GDAIS personnel during this period. Included in these costs were over-time labor-hours for the maintenance staff at an incremental level of approximately 8%. Included under the Buffalo support effort was a half-time Buffalo-based engineer in lieu of a full-time Edwards-based engineer. Funds for a nominal amount for computer tools, software, and recording media for data recording and analysis for AFTPS projects, ground simulation, and flights were also included. A task plan amendment (R01) increased the full-time Edwards-based staff by two maintenance/inspection personnel to bring

the total Edwards-based staff to six (engineering test pilot, one inspector, two mechanics, one technician, and one junior level technician/mechanic) for the months of March and April 2001. This increase in staffing was the result of discussions between AFTPS and GDAIS after the first six weeks of operations in 2001. It was readily apparent that the maintenance support staff of three was insufficient for standard operations at the AFTPS. Full-time inspection and record keeping, as well as assistance in basic aircraft maintenance activities were required. In addition, unbudgeted over-time was being used and was anticipated to continually be used at a high rate if the staff was not increased. Task plan amendment (R02) covered the costs to have Lockheed Martin repair the spare Digital Flight Control Computer (DFLCC). Task plan amendment (R03) covered VISTA operations under this task beyond the original end date of 30 April and through the end of September 2001. Task plan amendment (R04) reduced overtime labor by approximately 132 hours to meet the available budget. Task plan amendment (R05) covered VISTA operations under this task from 1 October through the end of December 2001. Task plan amendment (R06) in 2003 was a no-cost time-extension to allow GDAIS to provide additional VISTA descriptive, maintenance, and calibration documentation. This action was a result of a Government audit which allowed GDAIS to lower its General and Administrative (G&A) overhead rate for the 2001 calendar year. Due to this reduced overhead rate, approximately $30,000 in funding had become available on this task. This permitted GDAIS to revise or generate the following VISTA documents:

- Variable Stability System (VSS) Operational Checkout Procedures
- VSS Maintenance Manual
- Center Stick Calibration
- Side Stick Calibration
- Throttle Calibration
- Linear Accelerometer Calibration
- Rate Gyro Calibration
- Angle of Attack & Sideslip Sensor Calibration
- Signal Conditioning Chassis Sensor Checks

AFTPS flights flown during the year included FQ demonstrations, air to air evaluation, Electro-Optical evaluation, integrated systems evaluation, syllabus development (including AIM-9X and Maverick checkout), staff instructor pilot training, TMPs: Have Attitude & Have ROVER, demonstration flights for the Naval TPS & French TPS (EPNER), pilot currency, A total of 176 flights and 229.5 flight-hours were flown during this period.

Task 01-02 VISTA AFTPS Test Management Project Fall '01 – HAVE ROVER
Project Engineer: Andrew Markofski
Funding: $103,979

This task covered the use of the VISTA for an Air Force Test Pilot School Test Management Project (TMP) for Class 01-A in the Fall of 2000. The general objective of this TMP, called HAVE ROVER, was to evaluate both the ability of the Real-time Oscillation Verifier (ROVER) algorithm to detect incipient and developed Pilot-Induced Oscillations (PIO) and the ability of a dependent notch filter to prevent PIOs from occurring. The test team pilots evaluated the PIO tendencies of a variety of configurations using a HUD tracking task implemented on the VISTA. This project was part of the joint Air Force Institute of Technology (AFIT)/AFTPS program. The flight test results were incorporated into an AFIT Masters degree thesis. The project examined several test configurations implemented using the VISTA variable stability system (VSS). The test configurations represented four sets of longitudinal short period dynamic characteristics and a range of rate limits with additional variable time delay. Each of the pitch configurations contained stabilizing feedback gains to augment the bare airframe dynamics. The stabilization feedback signals and the command signals were summed and fed into a rate-limited elevator actuator. The bare airframe dynamics contained one unstable configuration (worst case) while the remaining configurations were stable but with undesirable characteristics. When not under rate-limiting the configurations had Level 1 handling qualities, and the short period characteristics were identical. The maneuvers were HUD tracking tasks. The tracking task symbology and sequences were similar to those implemented in VISTA for the AFTPS advanced flying qualities demonstrations. The HUD also displayed to the pilot whether the ROVER had activated or not, depending on the configuration. A total of 15 flights and 18.4 flight-hours were flown.

One additional task, not funded under this contract, but utilized the VISTA:

Virtual HUD for Lockheed Martin
Project Engineer: Randall Bailey

As part of risk reduction activities for the development of the a next-generation fighter cockpit for future aircraft, such as the Joint Strike Fighter (JSF) aircraft, Lockheed Martin Tactical Aircraft Systems (LMTAS) requested to use the VISTA and its programmable display system (PDS) capabilities for the demonstration and evaluation of a Virtual Head-Up Display (HUD) concept. This effort was not covered under this contract, but utilized the VISTA supplied by the AFRL in cooperation with AFTPS under a Cooperative Research and Development Agreement (CRADA). This activity was intended to leverage off of existing VISTA PDS capabilities to minimize set-up time and cost, but selected changes and modifications were made to allow more in-depth evaluation of key pilot-vehicle interface issues as risk reduction and concept demonstration activities. A benefit of this activity was an increase in capabilities of the VISTA PDS for future AFTPS use. The objectives of the VISTA Virtual HUD concept flight test were to develop and evaluate display formats and functionality, and evaluate the acceptability of using the a wide-field-of-view Helmet-Mounted Display (HMD) in place of a

HUD for the presentation of Primary Flight Reference (PFR) head-up flight symbology typically used during instrument flight. The VISTA Viper-IV HMD and Advanced Metal Tolerant Head Tracking systems generated Virtual HUD symbology and other selected configurations to test and evaluate the Virtual HUD concept. In addition, the Voice Recognition System (VRS) in VISTA was employed for evaluation of advanced Pilot-Vehicle Interface (PVI) concepts. This project was performed in the Spring and Summer of 2000. A total of 26 flights and 37.6 flight-hours were flown. In addition, one flight each was provided to a Swiss and South African Air Force pilot to demonstrate the Virtual HUD. These Flights were funded by BAE and took place in September 2000. A total of 2 flights and 2.6 flight-hours were flown.

5. Technical Memoranda

Technical Memoranda (TMs) written in support of this contract and associated tasks have been numbered sequentially for each of the AFRL in-flight simulator aircraft since the beginning of development of that aircraft by GDAIS. The TMs generated during this five year contract for the VISTA, TIFS aircraft, Study Tasks are provided in the following tables. Each TM listed contains the TM number, date, and title. Copies of these TMs can be obtained from GDAIS or AFRL files.

5.1 VISTA Technical Memoranda

Number	Date	Description
0178	23-Jul-99	Task Plan for Completion of NF16D System Integration
0179	15-Mar-99	Task Plan for Completion of VISTA NF-16D Computer Upgrade Phase II (Hawk Replacement)
0180	15-Mar-99	VISTA Boeing JSF IFS Calibration & Evaluation
0181	19-Mar-99	VISTA Simulation Verification for U.S. Air Force Test Pilot School Test Management Project VISTA NF16D Have Track
0182	30-May-99	Task Plan Part 1 Virtual HUD Evaluations
0183	28-Mar-00	Task Plan VISTA ASIP Completion
0184	21-May-99	NF16D Helmet Mounted Display
0185	4-Jun-99	L-Band Telemetry
0186	17-Jun-99	Program Status for VISTA Boeing JSF (X-32A) In Flight Simulation Preparation
0187	6-Jul-99	Preliminary T-2 Modification Document for Integration of Electric Throttle Command in the VISTA/NF-16D
0188	6-Jul-99	System Design & Interface Control Document for Integration of Electric Throttle Command in VISTA/NF-16D
0189	3-Aug-99	Task Plan for USAF Test Pilot School VISTA Training Fall 99

Number	Date	Description
0190	3-Aug-99	Task Plan for VISTA Simulation System (VSS) Software Development and Test Station (SDTS)
0191	24-Aug-99	Task Plan for Transition of VISTA Ops to Edwards AFB Fall '99
0192	1-Sep-99	VISTA NF-16D/F100-PW-229 IDEEC Envelope Clearance Flight Test Plan
0193	9-Sep-99	Test Plan for VISTA NF-16D Test Pilot School Demonstration and Training Flights
0194	15-Sep-99	Test Plan for VISTA NF-16D Regression Flights for Phase 2 Computer Upgrade
0195	27-Oct-99	Task Plan for Transition to CRADA Operations for the VISTA/NF-16D and TIFS/NC-131H
0196	30-Nov-99	Final T-2 Modification Document for Integration of Electric Throttle Command in the VISTA/NF-16D
0197	2-Nov-99	Proposal Virtual HUD Evaluations for LMTAS
0198	11-Nov-99	T-2 Modification Document for Instrumentation Of External Tailcone Flap In The VISTA/NF-16D
0199	16-Nov-99	Task Plan for Shutdown and Transfer of the VISTA/NF16D
0200	22-Nov-99	Service Difficulty Report - Failure of VISTA/NF-16D VSS1 Computer Centrifugal Blower Assembly
0201	14-Jan-00	Task Plan for USAF Test Pilot School VISTA Training Spring 2000
0202	3-Feb-00	Programmable Display System (PDS Symbology Description Document February 2000
0203	16-Feb-00	Task Plan for VISTA Demonstration Flights for the NASA Dryden Flight Test Center at Edwards AFB Spring 2000
0204	16-Feb-00	Task Plan for VISTA Demonstration Flights for the 411th Flight Test Squadron (F-22) at Edwards AFB Spring 2000
0205	16-Feb-00	Task Plan for VISTA Demonstration Flights for the 416th Flight Test Squadron (F-16) at Edwards AFB Spring 2000
0206	18-Feb-00	Task Plan for VISTA Virtual HUD Evaluations
0207	1-Mar-00	Helmet Mounted Display Latency Test
0208	5-Apr-00	VISTA Virtual HUD Flight Test Plan
0209	27-Mar-00	VISTA 048 Drawing Update
0210	27-Mar-00	Programmable Display System Maintenance support
0211	27-Mar-00	Programmable Display System Emulator
0212	28-Mar-00	AFTPS Syllabus Refinement
0213	28-Mar-00	Task Plan VISTA Pilot and Crew Training

Number	Date	Description
0214	1-Nov-00	Task Plan for VISTA NF-16D Variable Stability System (VSS) Spares
0215	31-Mar-00	Task Plan for VISTA MIL-STRIP Set-Aside
0216	5-Jun-00	Task Plan for VISTA USAF Test Pilot School Training - Summer 2000
0217	21-Jun-00	BAE Systems Demonstration Flights
0218	12-Jan-01	Task Plan for VISTA NF16D In-Flight Simulation of the X-34
0219	3-Aug-00	Task Plan for the VISTA NF-16D UAV Common Test Bed Program, Phase 1
0220	7-Aug-00	Task Plan for Foreign Test Pilot HMD Flights Sponsored by BAE Systems
0221	13-Dec-90	Signal Conditioning Chassis Assembly and Internal Wiring
0222	11-Aug-00	Task Plan U.S. Test Pilot School Test Management Project VISTA NF16D HAVE OLOP
0223	14-Aug-00	SCC Working Data
0224	15-Aug-00	Preliminary T-2 Modification Document for DGPS Equipment Installation in the VISTA/NF16D
0225	21-Aug-00	Task Plan ATTC Ground Demonstrations
0226	22-Aug-00	Task Plan for VISTA 300-Hour Inspection and Sidestick Repairs
0227	25-Aug-00	Task Plan for VISTA Transition to Air Force Test Pilot School Operations
0228	5-Sep-00	Program Summary from VISTA AFTPS Summer 2000 Demonstrations
0229	15-Sep-00	Task Plan for VISTA In-Flight Refueling Demonstrations for Sargent Fletcher, Inc.
0230	9-Oct-00	VISTA IP Training and Test Syllabus Development Flight Test Plan
0231	18-Oct-00	VISTA Virtual HUD Data Analysis Summary
0232	24-Oct-00	Program Summary from VISTA AFTPS Have OLOP Test Management Program
0233	16-Nov-00	Test Plan for VISTA NF-16D In-Flight Refueling Demonstrations for Sargent Fletcher, Inc.
0234	17-Apr-01	Task Plan Amendment for VISTA Air Force Test Pilot School 20001 Operations (Jan - May) Revised for May Operations
0235	5-Dec-00	Validation Data for HAVE OLOP
0236	30-Apr-00	Task Plan For VISTA Demonstration Flight for Korean Test Pilot
0237	17-May-01	Program Summary from VISTA AFTPS HAVE ATTITUDE Test Management Project

Number	Date	Description
0238	12-Jul-01	Task Plan U.S. Test Pilot School Test Management Project VISTA NF16D HAVE ROVER
0239	11-Sep-01	Task Plan for VISTA Air Force Test Pilot School Oct - Dec 2001 Operations
0240	9-Oct-01	Validation Memo for HAVE ROVER TMP
0241	6-Nov-01	Program Summary from VISTA HAVE ROVER TMP

5.2 TIFS Technical Memoranda

Number	Date	Description
1970	12-Mar-99	Task Plan for NASA HSR GFC FY99 Activities
1971	30-Mar-99	Task Plan for TIFS XVS Modifications for the NASA High Speed Research Program - FL5 Flight Test
1972	7-May-99	Overview of Modification of the TIFS for the NASA High Speed Civil Transport (HSCT) External Visibility Systems (XVS) FL5 Flight Test Program
1973	6-Jul-99	Final T-2 Modification Document - Upgrades to TIFS for the NASA External Visibility System (XVS) FL5 Fight Test Program
1974		Task Plan for NASA Synthetic Vision Flight Test
1975	5-Jul-99	TIFS EMC Tests Related to XVS - FL5 Modifications
1976	8-Oct-99	NASA HIGH SPEED RESEARCH (HSR) FL5 External Visibility System (XVS) and SV1 Synthetic Vision Flight Test Plan
1977	17-Sep-99	Extra TIFS Operations for NASA External Visibility Systems Flight Test
1978	7-Jan-00	Total In-Flight Simulator – TIFS Description and Capabilities White Paper
1979	11-Jan-00	Task Plan for Funds to complete NASA FL5 Flight Test Program
1980	1-Aug-00	Task Plan for IPTN Deferred Maintenance on TIFS

5.3 Study Task Technical Memorandum

Number	Date	Description
0004	25-May-99	Task Plan Wind Tunnel Model for the Study of Magneto-Aerodynamic Effects on the Shock Layer of a Sphere/Cylinder